



Surgical treatment of rib fracture nonunion: A single center experience

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ABSTRACT

Introduction: In contrast to the emerging evidence on the operative treatment of flail chest, there is a paucity of literature on the surgical treatment of rib fracture nonunion. The purpose of this study was to describe our standardized approach and report the outcome (e.g. patient satisfaction, pain and complications) after surgical treatment of a rib fracture nonunion.

Methods: A single centre retrospective cohort study was performed at a level 1 trauma centre. Symptomatic rib nonunion was defined as a severe persistent localized pain associated with the nonunion of one or more rib fractures on a chest CT scan at least 3 months after the initial trauma. Patients after initial operative treatment of rib fractures were excluded.

Results: Nineteen patients (11 men, 8 women), with symptomatic nonunions were included. Fourteen patients were referred from other hospitals and 8 patients received treatment from a pain medicine specialist. The mean follow-up was 36 months. No in-hospital complications were observed. In 2 patients, new fractures adjacent to the implant, without new trauma were observed. Furthermore 3 patients requested implant removal with a persistent nonunion in one patient. There was a mean follow-up of 36 months, the majority of patients (n=13) were satisfied with the results of their surgical treatment and all patients experienced a reduction in the number of complaints. Persisting pain was a common complaint. Three patients reporting severe pain used opioid analgesics on a daily or weekly basis. Only 1 patient needed ongoing treatment by a pain medicine specialist.

Conclusion: Surgical fixation of symptomatic rib nonunion is a safe and feasible procedure, with a low perioperative complication rate, and might be beneficial in selected symptomatic patients in the future. In our study, although the majority of patients were satisfied and the pain level subjectively decreases, complaints of persistent pain were common.

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Introduction

Rib fractures are common injuries, present in 10% of all trauma patients and in over 35% of patients after thoracic trauma [1]. The incidence of rib fractures is underestimated because up to 54% of rib fractures are missed on routine chest radiographs [2]. Although disabling and painful, the vast majority of fractured ribs will heal spontaneously without intervention. An unknown and presumably small percentage of patients develops rib nonunion and an even smaller percentage develops symptomatic rib nonunion with common complaints including chronic pain, dyspnea, clicking sensation or jabbing with respiration and shortness of breath [3,4].

Chronic, focal pain at the site of the nonunion is the dominant complaint of patients with rib fracture nonunion. Pain is present at rest and exacerbates through increasing physical effort. The first report of operative fixation for rib fracture nonunion, using bone graft splints, was by Leavitt in 1942 [5]. Due to a failure of the graft, two operations were needed before the result was satisfactory. The literature was subsequently silent on surgical intervention for rib fracture nonunion until 1996 when a single case of successful iliac crest bone grafting for rib fracture nonunion was reported by Morgan [6]. Since that time different techniques with or without bone grafting have been described.

In contrast to the emerging evidence on the operative treatment of flail chest, there is a paucity of literature on surgical treatment of rib fracture nonunion. Only 11 publications, representing 47 patients, about surgical fixation of rib fracture nonunion have been described [7]. The outcomes of operative treatment of rib nonunion have been described in several different

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manuscripts but most are case reports [5,6,8–15]. As various operative techniques are used, it is difficult to draw conclusions about treatment results.

The purpose of this study was to describe our standardized approach and report the outcome (e.g. patient satisfaction, pain and complications) after surgical treatment of rib fracture nonunion.

Methods

The study was part of a registry for the surgical fixation of multiple rib fractures and flail chest. The institutional review board of the University Medical Center Utrecht (UMCU) approved a waiver of consent under protocol number 17–544/C.

A retrospective cohort study was performed. All consecutive adult (age ≥ 18 years) patients who underwent surgical treatment of rib fracture nonunion at the UMCU from July 2010 to May 2015 were included. The UMCU is a large tertiary referral center for trauma care and a level 1 trauma center. Symptomatic rib nonunion was defined as severe persisting localized pain associated with nonunion of one or more rib fractures on a chest CT scan at least 3 months after initial trauma [3]. Patients after initial operative treatment of rib fractures were excluded.

Data were derived from a database, including all consecutive patients undergoing surgical treatment for rib fractures. Demographic data such as age, gender, smoking status, date of injury, trauma mechanism, date of surgery, number of rib nonunions, surgical implants used, number of ribs fixed, length of procedure, length of hospital stay and complications were collected from the database. All patients underwent a chest spiral computed tomography (CT) scan with 3 dimensional (3D) reconstructions to identify rib fracture nonunion and to optimize pre-operative planning.

Surgical procedure

All procedures were performed or supervised by one of the authors (MJ, LL), both trauma surgeons with extensive experience with surgical stabilization of rib fractures in an acute setting. Preoperative planning of the procedure was conducted using a chest CT with 3D reconstructions. All patients were asked to localize the painful areas. These areas were pre-operatively marked by the operating trauma surgeon.

Preoperative antibiotic prophylaxis (2 g of Cefazolin) was administered intravenously in all the patients. Depending on the site of the nonunion, patients were positioned in the supine, lateral or prone position and the surgical approach was performed as described by Taylor [16]. In the case of intercostal muscle interposition, debridement was performed followed by internal fixation using the MatrixRIB™ system (Depuy Synthes®, Amersfoort, The Netherlands) was performed. In case of hypertrophic rib nonunion without interposition, the fixation was done without debridement in order to provide stability.

To obtain a rigid fixation with maximum stability, locking plates were used. Reposition forceps were used to keep the plate in position. Fixation was preferably done with 3 bicortical screws on each side of the nonunion. After measuring the rib, a drill bit with a stop was used to prevent the parietal pleura from being penetrated. The use of bone graft (Tutoplast, Taureon®, The Netherlands) in case of a large gap after debridement was left to the discretion of the operating trauma surgeon.

Tube thoracostomy was only performed in the case of suspected pleural perforation during surgery. Postoperative chest radiography was performed in all patients to assess the surgical results and to rule out any complications. Patients were allowed to perform their daily activities as soon as possible.

Follow-up

The follow-up included at least one outpatient department visit 2 weeks after surgery with a chest radiography to rule out any delayed pleural effusion or hemothorax. Additional visits to the outpatient department were planned on individual basis because the majority of the patients had been referred to the University Medical Center Utrecht from more local ones. In these cases, a follow-up telephone consultation was conducted. This was at the request of the patient. For study purpose a telephonic interview was performed to assess outcome.

Outcome

The primary goal of this study was to evaluate and assess the satisfaction and pain levels after surgery. This was conducted via a telephonic interview. Satisfaction was assessed by asking a single question with a multiple choice answer (yes, yes after additional surgery, no). Pain was assessed through a series of questions. Patients were asked to record the level of pain on a numeric pain rating scale (NRS) from 0 to 10. On this scale 0 corresponds with no pain and 10 corresponds with the worst imaginable pain [17]. The use of analgesics and treatment by a pain medicine specialist were also recorded. These questions were based on extensive clinical experience and designed for easy use in a telephonic questionnaire.

Complications were evaluated by using electronic medical records. Non-union was defined as severe persisting localized pain associated with nonunion on a chest CT scan at least 3 months after initial surgery. Implant failure and implant removal were recorded. Implant removal was only performed at patients' request.

Statistical analysis

Variables are presented as a mean value with range for parametric continuous outcomes, as median with range for nonparametric continuous outcomes and as frequencies and percentages for categorical variables. Statistical analyses were performed using SPSS 21.0 software (SPSS Inc, Chicago, IL, USA).

Results

In the study period, operative stabilization of rib fractures was performed in 161 patients. Nineteen patients (11 men, 8 women), with symptomatic nonunions were included. Fourteen patients were referred from other hospitals and 8 patients received treatment from a pain medicine specialist. The mean follow-up assessment time was 36 months (8–65). Baseline characteristics are shown in Table 1.

Seven patients sustained their rib fractures in a motor vehicle accident, five from a fall, four sustained cough induced rib fractures, two during sports and one during thoracic surgery (esophageal resection). Only 3 patients had an Injury Severity Score (ISS) above 16 (range 22–34). The median time from injury to nonunion surgery was 19 months (range 5–398). The mean follow up was 36 months (range 8–65). One patient refused to participate in the telephonic interview.

The median length of surgery (skin-to-skin) was 43 min (14–91). Out of 42, a total of 40 rib fracture nonunions were fixated. In all cases locking plates were used. Table 1 shows the location of the rib nonunions. In 8 ribs we were unable to place 3 screws on each side of the nonunion because the fractures were located dorsally near the spine or scapula. Allograft bone was used in two cases because of a large bone defect. In two patients a chest tube was placed during the operation due to the opening of the pleural cavity. In both cases the tube was removed the next day. There

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